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ABSTRACT

College students' self-reported test anxiety levels in English, mathematics, physical science, and social science were compared to develop empirical support for the claim that students, in general, are more anxious about tests in rigorous academic subjects than in the humanities and to understand the curriculum-related sources of anxiety. It was hypothesized that students' perceptions of a subject's difficulty are correlated positively with their levels of test anxiety in that subject. It was assumed that students would report greater test anxiety when they believed mastery of a subject demanded precise answers on tests rather than a general understanding of the course content. First-year college students (N=196) (131 males and 65 females) were assigned randomly to groups using a 4 x 3 factorial design (4 levels of subject matter by 3 levels of test demand instruction). A revised version of the Worry-Emotionality Scale and a five-item scale describing their opinions and attitudes of the difficulty of the four academic curricular areas were used. Test anxiety scores and perceptions of subject matter difficulty correlated, independently of the particular subject and the test demands. Analyses of covariance indicate that physical science elicited the highest levels of self-reported evaluative anxiety, after controlling for perceptions of difficulty and test demands. Effects for test demand instructions were not significant. Results are discussed concerning the importance of subject matter as an intervening variable in test anxiety research generally and the significance of the role of test anxiety in impeding science achievement. (Contains 22 references.) (RLC)

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Test Anxiety and the Curriculum: The Subject Matters

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ABSTRACT

It has been suggested that students, in general, are more anxious about tests in rigorous academic subjects such as mathematics and science, than in the humanities. In an effort to develop empirical support for this claim and to understand the curriculum related sources of anxiety, we compared college students' self-reported test anxiety levels in four traditional academic subjects: English, Mathematics, Physical Science, and Social Science. In particular, we hypothesized that students' perceptions of a subject's difficulty were correlated positively with their levels of test anxiety in that subject. Further, we assumed students would report greater test anxiety when they believed mastery of a subject demanded precise answers on tests (i.e., detailed factual knowledge, precision, or sophisticated calculations), rather than a general understanding of the course content. Participants (N=196) were assigned randomly to groups using a 4 x 3 factorial design--four levels of subject matter by three levels of test demand instructions. Results suggest that test anxiety scores and perceptions of subject matter difficulty were correlated ($r = .57$, $p<.01$), independent of the particular subject and the test demands. ANCOVA results indicate that Physical Science elicited the highest levels of self-reported evaluative anxiety, after controlling for perceptions of difficulty and test demands. Effects for test demand instructions were not significant. Results are discussed both in terms of the importance of subject matter as an intervening variable in test anxiety research generally, and the significance of the role of test anxiety in impeding science achievement.

KEY WORDS: Test anxiety, science anxiety, curriculum, subject matter

There are many different constructs relating anxiety to learning from instruction. These include test anxiety or students' fears about evaluations of their learning, as well as more specific concerns about learning and being assessed in traditional academic subjects such as mathematics, science, public speaking, and writing (Dew, Galassi & Galassi, 1983; Hill, 1986; Mallow, 1982). Research in this area has made it abundantly clear that test anxiety is a significant educational problem for all levels of students--elementary, secondary, and postsecondary (Hill, 1984; Wigfield and Eccles, 1989). Indeed, forty years of research on this topic documents that highly test-anxious students do not perform as well as their less anxious counterparts on a variety of school-related tasks and in a number of academic settings (Benjamin, McKeachie, Lin, & Holinger, 1981; McKeachie, 1984; McKeachie, Pollie, & Spiesman, 1955; Sarason, 1980; Sieber, O'Neil, & Tobias, 1977).

Hembree (1988), in an extensive meta-analysis of 562 studies dealing with anxiety, reported negative correlations between test anxiety and achievement over a range of subjects, including English, mathematics, and the natural and social sciences. Moreover, it is often the case that highly anxious students are also weak academically, exhibiting inefficient study habits and difficulty organizing instructional material (Naveh-Benjamin, McKeachie, & Lin, 1987; Culler & Holahan, 1980; Everson, Millsap, & Browne, 1989).

Test anxiety research has also demonstrated that anxiety interferes most with performance when the cognitive capacity required by a task and the central representation of anxiety strained available intellectual resources (Paulman & Kennelly, 1984; Tobias, 1985, Everson, Millsap, & Browne, 1989). Research has found, for example, that anxiety effects were strongest in academic situations which pose a clear evaluative threat to students. In support of this notion, Hembree (1988) reported that students' perceptions of the difficulty of tests in various curricular areas were meaningfully related to their anxiety about those academic subjects.

It has been suggested recently (S. Tobias, 1992) that research comparing students' anxiety about different academic subjects would clarify the assumption --albeit derived largely from anecdotal evidence--that students are generally more anxious about academic subjects such as mathematics and natural science, than humanities or social sciences. If it is the case, as others (Naveh-Benjamin et al.,1987) have suggested, that highly test anxious students are poor organizers of course concepts and, further, if various academic subjects are viewed by students as more or less complex, then it is not unlikely that students' levels of test anxiety may vary across subject matter domains.

Thus, the primary purpose of this research was to compare students' self-reported anxiety in four traditional academic curricular areas: English, Mathematics, Physical Science, and Social Science. Specifically, we examined empirically the hypothesis that students' perceptions of a subject's difficulty were correlated positively with their levels of test anxiety about that particular academic area. Moreover, we investigated experimentally whether students' attitudes about the rigorous cognitive demands made by tests (i.e., test items requiring detailed factual knowledge, precision of estimates, or sophisticated calculations) in different content areas contributed to their anxiety about exams in those same subjects, independent of their perceptions of the subject's difficulty.

We reasoned, for example, if students believe that mastery of difficult subjects--like mathematics or physical science--requires accurate, detailed knowledge of specific rules and precise answers, then it was also likely they would feel that lack of competence would be relatively easy to detect by tests in these subjects. In turn, these subjects or courses should pose greater evaluative threats and evoke higher levels of anxiety. In an attempt to tease out the subtle differences of perceptions about the cognitive complexity of the subject itself from the demand characteristics of the tests in those subjects, we hypothesized that students would report greater test anxiety--regardless of how difficult or complex they perceived the subject matter to be-- when they believed that examinations generally required precise and accurate answers, rather than when they thought a more conceptual, less rigorous

understanding was required for mastery. Thus, this study attempted to test these hypotheses by manipulating experimentally and analytically subject matter assignment, students' beliefs about examination demands, and their perceptions of a subject's difficulty.

METHOD

Participants

A total of 196 first-year college students from a large urban university participated in the study. The sample was comprised of 131 males and 65 females. The students in our sample were ethnically diverse; 41% African American, 31% Hispanic, 18% Asian American, 5% White, and 5% others. The participants ranged in age from 17 to 38 years old, with a mean age of 21.

Procedure

Participants were randomly assigned to treatment groups in a 4 x 3 factorial design. The first factor was defined by asking students to rate their anxiety about tests in one of four traditional academic curricular areas (English, Mathematics, Physical Science, or Social Science) using a revised version of the Worry- Emotionality scale (Morris, Davis, & Hutchings, 1981). Participants also completed a five-item scale describing their opinions and attitudes of the difficulty of these same academic curricular areas. The second factor consisted of randomly presenting participants within each curricular area with examination-demand instructions which described the various curricular areas as requiring either (1) accurate and precise answers, (2) a general understanding of the content, or (3) a control condition specifying no particular set of requirements.

Three sets of identical instructions--varying only in one element--were developed which described the ways college professors determined students' knowledge in the four subjects. One version stressed that professors gave tests requiring a specific correct answer and relying heavily on students' knowledge of information and rules. The second version

stressed that professors looked for evidence that the content was understood and de-emphasized the need for specific correct answers. The control group's instructions simply asked participants to complete the scales the way they would feel while taking a test.

Materials

The Worry-Emotionality Scale (Morris et al., 1981) was adapted to elicit participants' anxiety about college level examinations in one of the four different subject areas. Participants were presented with ten items which asked them to rate their feelings, attitudes, and thoughts about tests using a Likert-type scale that ranged from one to five. Alpha=.87, Cronbach, 1951). Participants' perceptions about the difficulty of the academic subjects were measured using a five item Likert-type scale developed for this study (Alpha=.55, Cronbach, 1951). Examples of both scales are found in Appendix A and B, respectively.

RESULTS

The means and standard deviations of students' Worry-Emotionality scores and difficulty ratings, along with their correlations, for each subject area are presented in Table 1.

INSERT TABLE 1

In general, these data support the notion that students are more anxious when it comes to subjects like Mathematics and Physical Science, at least when contrasted with English or Social Science. Interestingly, the zero-order correlation between the Worry-Emotionality scores and measures of students' attitudes about subject matter difficulty was low ($r = .19$, $p<.01$). Although, in general, students' perception of a subjects' difficulty was related positively to their reported levels of test anxiety, the relatively weak correlation suggests other factors may influence anxiety ratings. These low correlations, is should be noted, may

be the result of the relatively low reliability (r=.55) of the rather brief attitudinal measure used in this study.

A 4 x 3 analysis of covariance of the Worry-Emotionality scores, controlling for students' perception of difficulty of the subject matter, revealed a significant main effect for curricular area ($F = 2.90$, $p<.05$), but not for test demand instructions.

INSERT TABLE 2

Further, an analysis of the differences among the various cell means, using a post hoc multiple comparison procedure (Scheffe, 1953; Weinberg & Goldberg, 1979) which permits the testing of all possible contrasts among the adjusted means, indicated that Physical Science elicited the highest test anxiety reports, once the effects for perceptions of difficulty and the demand instructions were controlled statistically. It was surprising that

INSERT TABLE 3

Physical Science was found to evoke significantly greater anxiety than Mathematics, in view of the large research literature dealing with mathematics anxiety (Hill, 1986). None of the other contrasted mean differences were significant. The interaction between test demand instructions and subject matter was not significant. Moreover, no significant main effects or interactions based on gender were found.

DISCUSSION

The research reported in this paper may advance our understanding of the effects of test anxiety on learning and instruction by highlighting and distinguishing the influences of students' perceptions about the difficulty or cognitive complexity of a particular academic subject, from their concomitant perceptions of the demand characteristics of tests in those

same subjects. For the most part, prior research on test anxiety has neglected these issues. Our analyses, although limited by the weakened reliability of an all too brief attitudinal measure, suggest that students' perceptions of a subject's difficulty may contribute to students' levels of test anxiety. In general, the more firmly students held the view that a particular subject was complex and difficult to master, the more test anxiety they reported, regardless of whether they thought tests in those areas were rigorous and demanding.

In the recent past we have progressed in our understanding of the various types of anxious students--test anxious, math anxious, and science anxious-- (Benjamin et al., 1981; Mallow, 1982; Tobias, 1985) and we have developed methods for ameliorating the effects of anxiety (Naveh-Benjamin, 1991). These approaches may be refined further by taking into account students' perceptions of the complexity of various academic subjects and the classroom level demands of many curricular domains. Programs designed specifically to address not only the information processing deficits of test-anxious students, but also their attitudes, beliefs, and perceptions about various curricular areas--like science and mathematics--may help reduce anxiety and enhance academic achievement in these curricular areas. WIthout doubt, progress will come from research which focuses on the extent to which these attitudes are malleable.

Equally surprising was the fact that when the influences of perceptions of difficulty and testing demands are controlled for, test anxiety levels still varied across subjects with Physical Science evoking the highest adjusted mean levels of reported test anxiety in our sample. This finding suggests that other instructionally meaningful factors, such as the classroom context (Helmke, 1988) and (or) the manner in which courses are "packaged" and presented by science faculty, may evoke strong feelings of anxiety in many college students.

Given the way that college-level science courses in the U.S. are organized and presented (i.e., "packaged") by science faculty (see Sheila Tobias, 1990), it is not altogether surprising that students assigned to the Physical Science condition in this study reported the highest

levels of test anxiety. Indeed, faculty expectations, as well as students' beliefs--ill founded or not--about science faculty expectations, may play a significant role in engendering anxiety in students. Shelia Tobias (1990), for example, has characterized college-level introductory science courses as painful and offputting, courses perceived by students as a place designed to select them out. In many cases these are classroom environments where failure is expected. Naturally, performance anxiety will be high in those contexts.

The results of this study do little to refute the view that science anxiety --i.e, the fear and avoidance of science courses-- is widespread on U.S. campuses (Mallow, 1982). Moreover, it is no secret that college students in the United States are woefully deficient in science and mathematics, and much needs to be done to enhance student achivement in these subjects. This study--with its emphasis on distinguishing the sources of anxiety in the curriculum--may encourage educators to take steps toward a comprehensive and differential approach to understanding and helping students overcome their anxiety about particular subjects, such as math and science.

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AUTHORS' NOTES

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APPENDIX A

Perception of Difficulty (Attitude) Scale

1. Thinking of all school subjects, how much time did you spend studying and doing homework in (curricular area).

   Most time of all Lot of time Not much time Least time of all

2. How did you feel about (curricular area) in comparison to other subjects?

   Liked it a lot Liked it a little Disliked it a little Disliked it a lot

3. Would you choose to take a course in (curricular area) if you did not have to?

   Very likely Probably Unlikely Very unlikely

4. Compared to other subjects, how difficult do you feel (curricular area) is?

   Very difficult Fairly difficult Fairly easy Very easy

5. How likely are you to choose (curricular area) as you major in college?

   Very likely Probably Unlikely Very unlikely

APPENDIX B

Worry-Emotionality Questionnaire (Adapted)

When answering the qu stions below, imagine you are take a test in (curricular area). To the left of each statement indicate what your feelings, attitudes, or thoughts would be if you were taking a test in (curricular area). Use the following scale to answer the questions:

1 = I would not feel that way at all.

2 = I would feel that way a little.

3 = I would feel that way to a medium degree.

4 = I would feel that way strongly.

5 = I would feel that way very strongly.

_____I would feel my heart beating fast.

_____I would feel regretful.

_____I would feel tense and my stomach would be upset.

_____I would feel that I should have studied more for that test.

_____I would feel uneasy and upset.

_____I would feel that others would be disappointed in me.

_____I would feel nervous.

_____I would feel that I may not do as well on that test as I could have.

_____I would feel panicky.

_____I would not feel very confident about my performance on that test.

Table 1. Means, Standard Deviations, and Zero-Order Correlations of the Worry-Emotionality Scale Scores and Difficulty Ratings by Subject Matter

	Mathematics		English		Social Science		Physical Science	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
	(N=50)		(N=50)		(N=53)		(N=43)	
Worry-Emotionality	21.2	7.7	20.0	6.4	18.5	6.9	22.7	8.2
Difficulty Rating	12.0	2.4	11.4	2.2	11.3	2.7	11.5	2.3
r	.12		.36		-.02		.30	

Table 2. Results of an Analysis of Covariance of Worry-Emotionality Scale Scores: Subject Areas By Instructions, Controlling for Perceptions of Difficulty.

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
Covariate					
DIFF.ATTITUDE	378.436	1	378.436	7.52	.007
Main Effects	552.593	5	110.519	2.20	.057
INSTRUCTIONS	92.038	2	46.019	0.91	.403
SUBJECT AREAS	437.929	3	145.976	2.90	.036
2-Way Interaction					
INSTRUCTIONS x SUBJECT	323.011	6	53.835	1.07	.382
EXPLAINED	1254.040	12	104.503	2.08	.020
RESIDUAL	9209.485	183	50.325		
Total	10463.526	195	53.659		

Table 3 . Adjusted Means of the Worry-Emotionality Scale Scores by Subject Area and Demand Instructions.

GRAND MEAN			
20.41			
(196)			
INSTRUCTIONS			
Accuracy		Understanding	Control
19.55		22.20	20.04
(69)		(70)	(57)
SUBJECT AREAS			
Mathematics	English	Social Science	Physical Science
21.05	20.17	16.51	25.22
(50)	(50)	(53)	(43)